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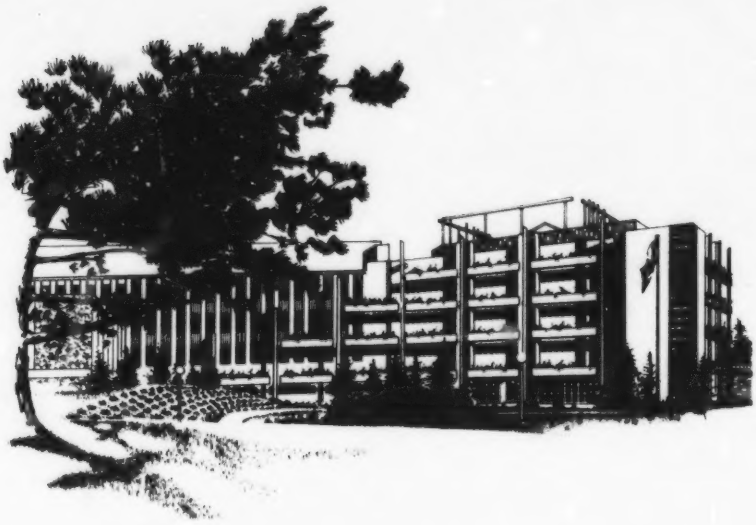
Hog fuel yield factors for British Columbia

M.R.C. Massie and G.H. Manning
Information Report BC-X-313
Pacific and Yukon Region

Energy ENFOR from the Forest



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BC-X-313

1989

90-02608/

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© Minister of Supply and Services Canada, 1989
ISSN 0830-0453
ISBN 0-662-17358-9
Cat. No. Fo46-17/31 3E
Printed in Canada

Additional copies of this publication
are available in limited quantities
at no charge from the
Pacific Forestry Centre

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MicroMedia Inc.
Place du Portage
165, Hotêl-de-Ville
Hull, Quebec
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Erratum: BC-X-313, Hog Fuel yield factors for British Columbia

Table 3, Pages 14-15 - For Coastal British Columbia a new set of species labels applies. From left to right:

Spruce	Lodgepole pine	Balsam fir	Douglas-fir	Cedar	Hemlock	Cypress	Other

Foreword

ENFOR (Energy from the Forest) is a contract research and development (R & D) program managed by Forestry Canada. It is aimed at generating sufficient knowledge and technology to realize a marked increase in the contribution of forest biomass to Canada's energy supply. The program was initiated in 1978 as part of a federal interdepartmental initiative to develop renewable energy sources.

The ENFOR program deals with biomass supply matters such as inventory, growth, harvesting, processing, transportation, environmental impacts, and socio-economic impacts and constraints. A technical committee oversees the program, developing priorities, assessing proposals, and making recommendations. Approved projects are generally carried out under contract.

General information on the operation of the ENFOR program, including the preparation and submission of R & D proposals, is available upon request from:

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This publication on ENFOR project P-350 is based on a report produced by Nawitka Resource Consultants, Victoria, British Columbia under contract DSS 01K51-7-0644/01-SB. The Scientific Authority was G.H. Manning, Pacific Forestry Centre, 506 West Burnside Rd., Victoria, British Columbia V8Z 1M5

Abstract

The history of utilization of woody biomass for fuel in British Columbia is reviewed. Utilization of the various potential components of hog fuel is discussed. A listing of hog fuel yield (by proportion of total volume) factors from merchantable logs, by TSA or supply block, and species grouping is presented.

Résumé

Les auteurs brossent l'historique de l'utilisation de la biomasse forestière comme combustible en Colombie-Britannique. Ils traitent de l'exploitation des diverses composantes des déchets de bois ayant un potentiel énergétique et présentent une liste des facteurs de rendement énergétique des déchets de bois (en fonction du volume total) résultant de la coupe des grumes à valeur commerciale, par région d'approvisionnement en bois (TSA) ou carré d'approvisionnement et par groupe d'essences.

Introduction

The Energy from the Forest (ENFOR) program of Forestry Canada has sponsored numerous studies[1] nationally and regionally to develop an inventory of the standing forest biomass in Canada. This inventory was published in 1985 by the Petawawa National Forestry Institute (Bonnor 1985). Other studies have been done in British Columbia to develop statements of the inventory of biomass which is economically available for energy conversion following harvest of the merchantable stand component (e.g. Manning and Massie 1986; Tunner and Standish 1986; Nagle et al. 1987). Others have reviewed the supply of mill residues (hog fuel) following manufacture of solid wood products (Reid, Collins and Associates 1978a and 1978b; Appleby 1988 and 1989). One report combined both types of material to provide an overall estimate of an economic supply function for forest-energy biomass in British Columbia (McDaniels and Manning 1987).

Unlike the studies done in British Columbia, the national biomass inventory (Bonnor 1985), which includes British Columbia, overstates biomass availability because merchantable portions of the tree bole are included in the estimates. In order to correct this problem for the British Columbia portion of the inventory, a contract was given to Nawitka Resource Consultants Ltd. in 1986 to develop detailed factors for the determination of hog fuel yield from the merchantable portion of the tree bole (as defined in the national biomass inventory). Such factors allow the conversion of the gross available biomass for British Columbia in the national biomass inventory to net available biomass.

'Waste' in British Columbia forest industries

Background and history

The amount of burnable material left over after economic wood products have been removed from the log in British Columbia has changed substantially over time. In the early days of British Columbia logging, some of the finest logs were bucked and split into firewood in the forest to fuel steam donkeys. Only straight, knot-free material was used to minimize the cost of hand splitting. Fir bark was also used for this purpose in the woods. Basically the same procedure was used to fuel the steam locomotives on the logging railroads.

In the logging setting, no hemlock or true firs generally were taken. Fir and cedar stumps were cut high to reduce the flare in the butt log so that mill waste could be minimized. Over 30% of the stand was left in the woods, even in the best timber.

Once at the mill, large circular saws produced one-half inch of sawdust with each pass. All slabs and edgings were burned. Over 50% of the volume reaching the mill was burnable waste, not counting bark (an additional 10-15%). All mills were steam-driven with wood fuels until the advent of hydro power and diesel engines.

From this wasteful base in the 1920s the industry has progressed steadily to the late 1980s where:

- all species are used
- mills are designed to maximize the output of wood products from medium to large logs
- special mills process small logs into many products, including studs and pulpable fibre.
- panel mills use waste from sawmills
- pulpmills use almost any form of clean bark-free wood material in a range of particle sizes
- limited chip exports are permitted
- wood-fired boilers are used by most pulpmills and some wood products mills for drying their products and other energy purposes.

There is now very little waste of material, once it is removed from the woods, in 1987.[2]

Sawdust

The proportion of sawdust generated in British Columbia mills declined steadily for over two decades to 1978, but has not changed radically from 1978 to 1988. This is interesting because there have been further reductions in saw width during the period, and significant increases in lumber yield per cubic metre of logs. There have been several factors at work:

- The average log size has gradually declined, and this leads to more sawdust in relation to total log volume.
- There are more cuts per log with thinner saws to generate higher lumber output.
- There have been various shifts in sizes of lumber cut — for example an historic decline in board (of thickness 1" and less) production and an increase in dimension lumber production. Also, there has been a slight decline in the width of dimension lumber. Recently there has been an increase in sawing of full size boards and timbers for off-shore markets.
- Band mills have gradually replaced circular

[1] A list of these studies is included in Bonnor (1985) pp 60-63.

[2] There is some current controversy over material left in the woods.

saws, although some circular saws are still used At the extreme, guided band saws with water cooling produce minimum saw kerf with current technology. There are limits to what can be achieved with these methods — the feed speed of the saw carriage affects mill economics directly and the thinnest saws are slower.

Also, pure wood dust combined with water is not as good a pulpable material as normal sawdust. Some new band saws produce longer thin particles rather than dust. In general, saving 1-2% of the log from sawdust while losing 10% of the log from pulpable material is not a good trade.

- Automatic log scanning and measurement, together with computer optimizing schedules, permit improved log breakdown to maximize lumber output. The same tools provide more lumber with less sawdust at subsequent stages of mill breakdown (e.g. optimizer edgers).

In the coastal region of British Columbia in 1987, an average of 13.8% of the log volume entering sawmills exited as sawdust. In the interior region of the province the average proportion was 12.5%.

Although the production of sawdust has not changed radically in the past decade, the utilization of sawdust has changed. More sawdust is being pulped. At present, 9-13% of current sawdust production is pulped in the interior and 36-48% is pulped on the coast; in British Columbia, an average of 20-25% of sawdust is utilized in fibre products. These proportions will continue to increase gradually with installed capacity of appropriate sawdust-using facilities.

Facilities that pulp sawdust will generally be able to out-bid an energy user for this fibre (in all species except cedar) as long as oil prices remain below $40/barrel. At current energy prices, clean whitewood sawdust is an economic fibre source for mills equipped to use it. In addition, dry-process particleboard mills can use some sawdust in producing panels for the furniture and construction industries.

Shavings

After sawing, each piece of lumber going to the dimension market goes through a high-speed planer to produce exact size, smooth surface on four sides, and slightly rounded corners. The most radical change in the non-lumber outputs of British Columbia sawmills in the past decade has been in the shavings and dust produced in this process. The amount of this material produced has declined by nearly 50% in the interior region, the biggest producer of dimension lumber. The average for all sawmills in the interior in 1987 is about 6%, down from about 11% in 1978. At present, the coastal region produces about 3% of shavings from total sawlog supply, down from about 4% in 1978.

The principal cause of the decline is more accurate sawing. With more accurate rough-sawn material, the planer can be run faster and the amount of material removed to get a smooth surface is lower. Also, since older mill systems had to provide for worst-case sawing accuracy, the operating pre-planer tolerances were quite large (under-size lumber would be seriously downgraded or chipped as waste because no rough patches were permitted in dimension lumber). The present industry is very close to the minimum tolerances on sawing accuracy. Therefore, future declines in shavings production will likely be modest.

A further element in the decline of shavings is the increase of rough sawn material being sold. Off-shore markets (such as the United Kingdom, other European countries, and Japan) generally use rough sawn lumber. Accurate sizes are also required for these sawn-to-size markets. Consequently, no shavings are produced from this material. Coast production of full sawn material has always been higher than that of the interior due to a higher proportion of off-shore markets. In recent years the proportion of full sawn lumber from interior mills has been gradually increasing.

Meanwhile, the increasing tendency to re-manufacture lumber products in British Columbia is producing more shavings. The making of moldings, shaped siding, and other woodworking items produces shavings material. As most of these industries have in past years been relatively small and decentralized, this material has not been considered in the waste coefficients. As remanufacturing increases in the 1980s, this industry will provide a significant amount of burnable waste.[3]

Any developments which increase the use of rough sawn material in North America or which lead to increasing fractions being exported to off-shore markets will lead to a significant decline in shavings output. On the other hand, current marketing efforts of the Council of Forest Industries of British Columbia are aimed at increasing the use of dimension lumber in Japan and China through adoption of North American framing systems. To the degree these efforts are successful they could increase the production of shavings, especially on the British Columbia coast.

[3] Madison's Canadian Lumber Directory lists 31 re-manufacturers in B.C. in 1983 and 77 in 1988.

Cedar wastes

The materials left over after processing western red cedar (*Thuja plicata* Donn) are different than those left from other species. The chemicals in this species which produce its durability and deep color make it unsuitable for standard pulping processes. These corrosive chemicals make it essential to use stainless steel tanks and pipes throughout the process. In addition, cedar pulps require more bleaching to achieve equivalent whiteness. Some of the corrosive problems exist in briquette manufacture and even in burning cedar wastes. Nevertheless, cedar is used extensively as a fuel due to its excellent burning properties and relative abundance.

Cedar shingle and shake mills are markedly different from other wood product mills in their waste outputs. There is more solid waste from the knotty and crooked material and shingle mills produce more sawdust. Although many of these mills are small and scattered, making collection of burnable waste more difficult, these mills are a good source of fuel.

Also, compared to most other species, a higher fraction of cedar lumber is re-manufactured. Many forms of siding and fancy boards are produced from western red cedar. This results in more shavings.

These differences result in different coefficients; in general more burnable material is produced from western red cedar. As a result, a lot of burnable cedar waste is produced in British Columbia.

In recent years North American and international cedar markets have been steady and high. The availability of mature western red cedar logs is quite limited in western North America. British Columbia is reported to have over three-quarters of the remaining reserves of mature *Thuja plicata*, and in British Columbia about 11% of the annual harvest is western red cedar.

Veneer and plywood wastes

Wastes from a plywood mill are quite different than wastes from a sawmill. Plymill wastes include:

- the unpeelable core of the log (nicely rounded, 10-20 cm in diameter, clean material)
- clippings and wastes from the veneer line (clean, green material, ready for chipping)
- wastes from trimming the plywood sheet after gluing (not pulpable due to the glue)
- sander dust (very fine, dry material, used for fuel).

Veneer cores have been put to a range of uses. Most mills now saw cores to produce studs and chips, but some mills chip cores directly for pulp furnish. The clippings and wastes from the veneer line have been used as pulp furnish on the British Columbia coast and interior for many years.

Lumber and pulp market effects

Mill hog coefficients, and hence the factors developed in this report, can change if the relative price or production of lumber and pulp changes. In the past in British Columbia, with soft lumber markets, lower grades have gone directly into the chipper. When lumber production relative to pulp production increases, the hog factors will increase; when lumber production relative to pulp production decreases, the factors will decrease. Provided that mill inputs do not change significantly, the maximum change in hog fuel yield factors will occur when both lumber production and pulp production increase significantly in the same time period (which would result in smaller factors) or when they both decrease significantly in the same time period (which would result in larger factors). In essence, if the quantity and quality of mill inputs (debarked stems) are constant, more hog will result when less products are made and less hog will result when more products are made.

The component mill coefficients for 1987/88 (Table 1) have declined to the point where very little more pulpable wood can be obtained from these sources. Sawdust is now being used to the extent that this component coefficient has effectively declined from about 13% to 10% (the component coefficients shown include pulpable sawdust).

Shavings have declined to 3% on the coast and to about 6% in the interior and are thought to contain little more pulpable fibre that can be extracted in the near future. Miscellaneous hog has declined to 2% and this residual contains dirt and impurities which prevent its further use.

Finally, as the British Columbia markets for all wood raw materials tighten, an increasing fraction of the standing forest will become merchantable, and will be extracted to yard and mill-site. This material will contain a higher burnable fraction, on average, than the standard logs of the late 1980s.

Analysis

Factors were developed for timber supply areas on the basis of mill coefficients. Each area was considered on the basis of timber type and mills supplied. Where relationships were unclear, average coefficients were

Table 1. Residual hog fuel coefficients (not including bark) for typical mills in British Columbia by region and type of sawmill

	1978/79				1987/88			
	Sawdust	Shavings	Misc.	Total	Sawdust	Shavings	Misc.	Total
Nelson Region								
Dimension Mills (SPF/FL)[1]	.12	.10	.03	.25	.12	.05	.02	.19
Dimension and Other (All Species)	.13	.11	.04	.28	.12	.08	.02	.22
Kamloops Region								
Dimension Mills (SPF/FL)	.13	.11	.02	.26	.13	.07	.02	.22
Dimension and Other (SPF/FL/HF)	.13	.11	.03	.27	.13	.07	.02	.22
Dimension and Other (C)	.14	.12	.03	.29	.14	.08	.03	.25
Cariboo Region								
Studs and Dimension (SP/FL)	.12	.12	.02	.26	.12	.05	.02	.19
Prince George Region								
Studs and Dimension (SP)	.14	.11	.03	.28	.13	.05	.02	.20
Dimension and Other (SPF/FL)	.14	.12	.04	.30	.14	.06	.02	.22
Prince Rupert (Interior) Region								
Studs and Dimension (SPF/H)	.12	.11	.03	.26	.12	.06	.02	.20
Dimension and Export (SPF/H)	.13	.10	.04	.27	.13	.06	.02	.21
Dimension and Other (SPF/HF/C)	.14	.12	.04	.30	.13	.07	.03	.23
All Coastal Regions								
Dimension and Boards (C)	.15	.04	.02	.21	.15	.04	.02	.21
Dimension and Export (F/H)	.13	.03	.02	.18	.13	.02	.02	.17
Cargo Dimension (F/H)	.13	.04	.03	.20	.13	.03	.02	.18
Dimension and Other[2] (H)	.14	.05	.02	.21	.14	.04	.02	.20
Other Mills[3]								
Small Coast Mill[4] (no chipper)	.14	.04	.40	.58				
Small Coast Mill (with chipper)	.13	.03	.02	.18				
Small Southern Interior Mill (no chipper)	.15	.09	.39	.63				
Small Southern Interior Mill (with chipper)	.14	.08	.02	.24				
Small Northern Interior Mill (no chipper)	.15	.07	.42	.64				
Small Northern Interior Mill (with chipper)	.14	.06	.02	.22				
Shake and Shingle Mill (no chipper)	.26	nil	.32	.58				
Shake and Shingle Mill (with chipper)	.26	nil	.05	.31				
Plywood Mill (See Note)	<.01	<.01	.10-.15	.11-.15				

[1] Lumber species classifications: SPF - spruce-pine-fir, SP - spruce-pine, FL - fir-larch, F - fir, HF - hem-fir, H - hemlock, C - cedar

[2] Other can include boards, ties, decking and miscellaneous specialty items

[3] Insufficient sample for time comparison; general factor estimated for last several years

[4] In general, permanent mills that cut less than 100 000 m^3 annually

Note: This is a general estimate only. There are complex differences between mills and/or regions.

used that reflected mills in the general supply area as well as the proportions of whitewood (pine, spruce, balsam and hemlock), cedar and other softwoods, largely Douglas-fir and larch, coming from the supply area.

In some areas sawmill coefficients will not be precise in estimating hog-fuel from merchantable stem wood as some minor unknown volumes were chipped for pulpwood, log exported, used for posts, poles and piling, or shipped over long distances to veneer and specialty mills. Coefficients were available for some veneer and plywood mills and for some shake and shingle mills but most of these could not be related to specific inventory or supply areas. The factors developed in this report pertain almost entirely to sawmilling and reflect mainly larger mills. Similarly, remanufacturing at centers other than the mills sampled was not identified. Altogether, factors based on sawmilling should be accurate, as it is by far the largest utilization practice. The effects of roundwood utilization (e.g. log exports) and remanufacturing will tend to counteract one another; the former generates no hog-fuel and the latter generates more than sawmilling.

The hog fuel factors for timber supply areas developed in this report are based on data from the years 1978-1988. They represent the technology being used in forest products manufacturing during that period in British Columbia, as well as the timber being harvested during that period. They reflect specific utilization levels on a sub-regional basis: the size, species and quality of timber being harvested in the sub-region, and the burnable waste being generated by the industry in that region or sub-region. Attention was focused on sawdust, other dust, shavings, trim, and miscellaneous scrap wood generally called hog-fuel. Where bark was included as a component of hog-fuel, the percentage was estimated and deducted.[4] Re-manufacturing was not considered unless it was conducted as an integral part of the production process at the site of the primary mill considered.

The factors[5] shown in Table 2 relate to forest inventory being utilized in the time period 1980 to 2000 and are location-specific. They do not relate to any specific manufacturing facility. The amount of hog-fuel generated per unit volume of log input is related to mill technology and to market demand for the products manufactured from the logs. Possible variations which might result from changes in technology or product demand have been discussed previously.

In order to relate the analysis to national biomass inventory cells, it was necessary to establish which manufacturing centers used which Timber Supply Areas (TSAs). The British Columbia Ministry of Forests Timber Supply Area analyses issued in the early 1980s provide data on the areas (supply blocks) within TSAs from which companies draw an annual harvest or quota. Note, however, that a unique relationship between one mill and one supply block cannot be established. A large mill usually draws from many supply areas; a small mill from a few. Conversely, a large supply area or block usually provides timber to more than one mill. A small area or block on occasion does supply only one mill, but in most cases that mill also receives timber from other areas or blocks.

In the interior of British Columbia supply blocks were mostly too small and TSAs too large to develop a unique relationship with mill capacity. For this reason, groups of supply blocks were most frequently the common denominator upon which the factors were developed. No individual supply blocks were reported that related to only one mill, but a few were reported that related to two mills. Similarly, where supply block relationships could not be established or where the timber type was uniform over large areas, reporting was on a TSA basis. For the coast, a combination of supply blocks and Tree Farm Licenses (TFLs) was used.

Determining hog fuel coefficients on the coast was much more complex than in the interior. Mills on the coast are large, and because of the relative low cost of ocean transport of timber, mills draw timber from widely diverse areas. Also, depending on the products cut, the age of the mill, the size of the company (internal integration with a pulpmill) and variety of processing facilities, hog-fuel production varied more than in the interior.

Hog-fuel coefficients related well to the species mix processed within a region. Therefore the species cut at each mill and the species mix of mature timber in an inventory area were major criteria in determining a match between mill data and inventory data. For instance, a supply area having both spruce and pine, as well as fir and larch, would relate to a mill in the region drawing wood from the same general area provided the mill mix approximated the inventory mix. If this was not the case, data from two mills, one processing spruce and pine and the other processing mainly fir and larch were combined to approximate the inventory mix of the supply area.

Table 3 indicates the species mix found in TSAs or comparable blocks throughout British Columbia. A summary is also provided by region and is shown in comparison to the actual cut in 1980 and 1985. This indicates that while there are noticeable differences in the species mix at the TSA level, at the regional level the

[4] Bark is included as a separate category in the national biomass inventory.

[5] Hog fuel **factors** are related to inventory areas; hog fuel **coefficients** are related to mill types.

species mix of the available inventory is close to what mills were utilizing in the early 1980s. Where some differences do occur, minor changes in the mix of species being utilized by the mills can be expected in the next decade. This should not change the factors estimated in this report significantly; the factors did not vary much within regions regardless of the species mix cut, with the possible exception of a few small local mills or a few mills cutting cedar.

Mill coefficients were derived on the basis of comparing cubic metres of debarked logs processed with cubic metres of products produced; the difference in these two quantities gave the residues. Residues were divided into three major categories: sawdust, shavings, and miscellaneous hog. In some cases bark had to be estimated and deducted as some mills included bark in their residue figures.

Hog coefficients varied between mills for a number of reasons. Timber type and quality have some effect. In addition, the following could change the amount of residues produced by a mill:

1. species
2. supply area(s)
3. product demand (including pulp chips)
4. markets and product mix
5. company log exports
6. mill technology (including debarking)
7. size of mill
8. utilization standards for harvesting
9. log sales or trades

Various materials (i.e. small stems, defective stems, and broken stems in whole or in part) are left in the woods under current conditions. The component of merchantable stems extracted depends on the utilization standards in effect. The coefficients in this report relate to slightly above average stem quality and size as they were developed during a period when utilization standards were moderate.

Hog fuel coefficients can change significantly if several factors work in concert. Thus, the causes of variations in coefficients between mills may not be immediately apparent. Modern mills can have high coefficients, mills cutting high-quality timber can have high coefficients, and some older mills cutting poorer quality timber can have low coefficients.

Hog fuel coefficients are strikingly uniform in interior and coastal British Columbia. Individual mills can vary, but the regional averages show much less variation. This leads to the conclusion that species and quality differences in the forest resource are not overriding factors in coefficients and that the other factors mentioned play a major role in determining the mill residues. Average mill coefficients for residue components are shown in Table 3.

The hog-fuel estimated for an area may or may not be available for burning, it may or may not be for sale or marketable, and that it may or may not be mixed with bark. As previously noted, even under current conditions, about 20-25% of the sawdust generated in the province is being used as a pulp fibre input. In general, this would lower the factors shown by about 0.03 if pulpable sawdust were classified as a product rather than hog-fuel.

References

Appleby, P.W. 1988. Hog fuel availability in the south coastal region of British Columbia: 1985. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-297.

Appleby, P.W. 1989. Hog fuel availability in the north coastal and interior regions of British Columbia: 1986. For. Can. Pac. For. Cent. Inf. Rep. BC-X-308.

Bonnor, G.M. 1985. Inventory of forest biomass in Canada. Can. For. Serv., Pet. Nat. For. Inst.

British Columbia Ministry of Forests. Various dates. Timber supply area reports. Victoria, B.C.

Madison's. Canadian lumber directory. 1988. Vancouver, B.C.

Manning, G.H.; Massie, M.R.C. 1986. Characteristics of logging residues in the Vancouver Forest Region, 1981. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-279.

McDaniels, T.L.; Manning, G.H. 1987. Estimation of the supply of forest biomass for energy conversion in British Columbia. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-294.

Nagle, G.S.; Massie, M.R.C.; Robinson, G.; Oakley P.; Manning, G.H. 1987. The economics of residual fuel and fibre production on the B.C. coast. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-289.

Reid, Collins and Associates. 1978a. Hog fuel availability in British Columbia. B.C. Woodwaste Coordinating Committee, Vancouver.

Reid, Collins and Associates. 1978b. Hog fuel availability study, south coast region. B.C. Woodwaste Coordinating Committee, Vancouver.

Tunner, A.; Standish, J.T. 1986. Predicting logging residues in British Columbia. Can. For. Serv. Pac. For. Cent. Inf. Rep. BC-X-284.

Table 2. Hog fuel factors by inventory area[1]

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Nelson Forest Region		
Golden TSA		
Blocks A, D	S C H B	.23
B, E	S F B H	.22
C, F, G	S Pl F B	.21
Boundary TSA		
Blocks A, C, D, E	Pl F L S	.19
B, F, G	Pl S L B	.21
Arrow TSA		
Blocks A, B, D, E, G, H	F H S C	.18
C, F, I, J, K, L	Pl S F L	.21
M	F L B S	.24
Cranbrook TSA		
All Blocks:	Pl S F L	.19
Invermere TSA		
All Blocks	Pl F S L	.20
Revelstoke TSA		
Blocks A, B, C, D, E	H C S B	.22
F, G	C H F S	.21
Kootenay Lake TSA		
Blocks A	S H C F	.18
B, C, D, E, F	F S B H	.22
G, H, I, J	Pl S B L	.21
Kamloops Forest Region		
Lillooet TSA		
All Blocks:	Pl F S B	.21
Merrit TSA		
All Blocks:	Pl F S B	.23
Okanagan TSA		
All Blocks and TFLs	Pl S F B C	.22
Kamloops TSA		
All Blocks and TFLs	S F Pl C B	.22

[1] Derived from mill coefficients in the Timber Supply Area and/or the Region. Includes the use of weighted average mill coefficients and/or coefficient adjustments on the basis of products manufactured, technology and species.

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Cariboo Forest Region		
Williams Lake TSA		
Junction Cariboo Upper Horsefly	S C B Pl	.19
Moffat Anahim	Pl S F B	.19
Spri. ghouse Chilcotin	F Pl S B	.19
Skelton Churn Palmer Lake Gaspard Kloakut Chezacut Tatla	Pl F S	.21
100 Mile TSA		
Canim	S B Pl F	.19
Ruth Sheridan Bonaparte	Pl F S	.18
Rail Holden Loon Meadow	Pl F S[3]	.19
Quesnel TSA		
S Kluskus Narcosli W. Narcosli E.	Pl S	.19
Special Sale Area TFL 5	Pl F S	.19
Cottonwood Big Valley Bowron Cunningham	S Pl B	.20

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

[3] Pine and Fir almost equal proportions

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Prince George Forest Region		
Fort Nelson TSA		
All Blocks	S Dec[4] Pl	.23
Peace TSA		
All Blocks	S Pl B	.20
Mackenzie TSA		
All Blocks	S Pl B	.21
McBride TSA		
All Blocks	S B C Pl	.24
Prince George TSA		
Blocks A, B	S B Pl	.22
C, D, F, I	Pl S F	.23
E, G	S Pl B	.22
H, TFL 30	S B C	.26
Prince Rupert (Interior) Forest Region		
Kalum TSA		
Blocks A, B, C, F TFL 41	H B C S	.22
Blocks D, E TFL 1	H B S C	.21
Bulkley TSA		
Blocks A	H B S Pl	.20
B, C	Pl S B H	.19
Kispiox TSA		
All Blocks	B H S Pl	.22
Morice TSA		
Blocks A, B, C	Pl S B	.19
D, E	Pl S B	.18
Lakes TSA		
Fleming Sutherland Pinkcut	Pl S B	.20
Maxan-Tchesinkut Takysie Binta-Knapp Natalkuz	Pl S	.24

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

[4] Deciduous, largely *Populus* species

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Prince Rupert (Coastal) Forest Region		
North Coast TSA		
Stewart	H C B S	.24
Alice Arm		
Skeena	H C S B	.23
Outer Coast		
Douglas	H C	.26
Mid Coast TSA		
Dean	H C B	.21
TFL 25		
Rivers Inlet	H C B Cy	.20
TFL 39		
Vancouver (Coastal - Mainland) Forest Region		
Kingcome TSA		
(E) Loughborough Broughton TFL 17, 12, 36 Parts of TFLs 2, 25, 39	H C B Cy	.21
(N)Klinaklini	F H C B	.22
(W)Seymour That Part of TFL 39 on the Southern Boundary	C H Cy B	.23
Quadra TSA		
(N & E)Bute Jervis TFL 10	H F B C	.21
(W & S)Powell R. Sechelt TFL 39	F H C B	.22
Soo TSA		
(N) Pemberton	B F H C Cy	20
(SW) Squamish TFL 38	H B F C Cy	.19
(SE) Port Douglas	F B H C Cy	.18

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Vancouver (Coastal - Mainland) Forest Region (Continued)		
Fraser TSA		
(W)Chehalis Stave Upper Pitt Maple Ridge TFL 26	H B F C	.19
(E)Nahatlatch Yale Harrison Chilliwack	B H F C	.20
Vancouver (Island) Forest Region		
Kingcome TSA (Island Component)		
(NW) Brooks	H B C	.19
(N)Cape Scott TFL 6	H C B	.20
Part of TFL 2, 25, 39 and TFL 37	H B F C	.18
Island TSA and Related		
(NE) Sayward Part of TFLs 25, 39 TFL 7	H B F C	.18
(E) Campbell R[5] (SE) Nanaimo[5] (S) Cowichan[5] Private land and Part of TFLs 2, 20, and 25	F H C B	.17
Nootka TSA and Related		
(NW) Kyuquot (SW) Barkley TFLs 19, 20, 21, 27 Most of TFL 22 Part of TFL 25	H C B F	.19

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

[5] These three areas contain more private forest land than Crown land; the private land species mix was incorporated to accurately reflect the species mix in total.

Provincial forest region TSA and/or supply blocks	Major species[2] (Descending order)	Ratio of residual hog to merchantable wood, inside bark
Vancouver (Queen Charlotte Islands) Forest Region		
Queen Charlotte TSA		
All Blocks and TFLs	H C S Cy	.20

[2] Lp = lodgepole pine; S = spruce; B = balsam fir; F = Douglas-fir; L = larch; C = cedar; H = hemlock; Cy = Cypress

Table 3. Mature species composition (%) for inventory and cut for British Columbia Timber Supply Areas[1]

	Species							
	Spruce	Lodgepole pine	Balsam fir	Douglas-fir	Larch	Cedar	Hemlock	Other
Interior British Columbia								
Nelson Forest Region								
Boundary TSA	16	35	10	20	14	2	1	2
Arrow TSA	15	15	12	24	11	7	12	4
Cranbrook TSA	21	37	9	14	11	1	1	6
Golden TSA	46	13	2	16	-	15	8	-
Invermere TSA	25	36	5	26	6	1	-	1
Kootenay Lake TSA	24	12	12	24	9	7	11	1
Revelstoke TSA	19	1	10	13	1	27	28	1
Regional average 1980	25	23	9	20	8	6	7	2
Cut 1980[2]	18	30	9	7	3	14	13	6
Cut 1985[2]	26	29	10	11	5	11	6	2
Kamloops Forest Region								
Lillooet TSA	26	28	15	28	-	-	-	3
Merrit TSA	28	42	6	22	-	-	-	2
Okanagan TSA	22	24	15	15	3	10	8	3
Kamloops TSA	34	19	9	22	-	9	6	1
Regional average 1980	28	26	11	21	1	6	5	2
Cut 1980[2]	28	28	13	14	1	9	6	1
Cut 1985[2]	27	37	10	17	1	5	2	1
Cariboo Forest Region								
Williams Lake TSA	23	43	6	22	-	4	2	-
100 Mile TSA	20	46	4	29	-	1	-	-
Quesnel TSA	39	42	7	12	-	-	-	-
Regional average 1980	29	43	6	19	-	2	1	-
Cut 1980	26	45	4	22	-	3	-	-
Cut 1985	24	52	4	17	-	2	1	-
Prince George Forest Region								
Fort Nelson TSA	54	13	-	-	-	-	-	33
Peace TSA	69	26	5	-	-	-	-	-
Mackenzie TSA	52	27	21	-	-	-	-	-
McBride TSA	54	6	22	4	-	9	5	-
Prince George TSA	45	31	18	3	-	1	-	2
Regional average 1980	50	27	16	2	-	1	-	4
Cut 1980	55	32	10	2	-	-	-	1
Cut 1985	56	31	11	2	-	-	-	-

[1] Inventory estimated for merchantable timber from 1980 to the year 2000. Cut estimated for 1980 or 1979/80 and 1985 or 1985/86. Large TSAs on the Coast subdivided where data available. TFLs not available on an individual basis.

[2] Provincial Crown Licences; 1985 not including Small Business Enterprise Program sales.

	Species							
	Spruce	Lodgepole pine	Balsam fir	Douglas-fir	Larch	Cedar	Hemlock	Other
Prince Rupert (Interior) Forest Region								
Kalum TSA	7	-	34	-	-	2	57	-
Bulkley TSA	25	30	22	-	-	-	23	-
Kispiox TSA	12	5	48	-	-	2	33	-
Morice TSA	36	39	25	-	-	-	-	-
Lakes TSA	30	64	6	-	-	-	-	-
Regional average 1980	22	26	28	-	-	1	23	-
Cut 1980	26	36	16	-	-	4	18	-
Cut 1985	31	36	14	-	-	3	16	-
Coastal British Columbia								
Prince Rupert (Coastal) Forest Region								
North Coast TSA	7	-	2	-	19	72	-	-
Mid Coast (Northern Portion)	7	-	15	4	32	40	2	-
Mid Coast (Southern Portion)	3	1	16	2	32	34	12	-
Prince Rupert Coast TFLs	14	-	7	-	30	45	4	-
Regional average	9	1	11	1	31	40	7	-
Cut 1980	16	-	13	2	21	46	2	-
Cut 1985	19	-	11	1	27	40	2	-
Vancouver Forest Region								
Mainland								
Kingcome (East) Loughborough and Broughton	2	-	14	1	32	41	9	1
(North) Klinaklini	3	1	11	44	12	27	-	2
(West) Seymour	2	-	8	-	51	26	13	-
Quadra (North and East) Bute and Jervis	2	-	18	23	17	36	3	1
(West and South) Powell River and Sechelt	-	-	12	35	13	33	6	1
Soo(North) Pemberton	1	1	33	32	8	22	2	1
(Southwest) Squamish	-	-	35	15	9	38	2	1
(Southwest) Point Douglas	-	-	25	41	7	24	2	1
Fraser (West)[3]	-	-	24	18	16	34	7	1
(East)[4]	4	1	30	24	8	30	1	2

[3] Western Supply Blocks - Chehelis, Stave, Upper Pitt, Maple Ridge

[4] Eastern Supply Blocks - Nahatlatch, Yale, Harrison, Chilliwack

	Species							
	Spruce	Lodgepole pine	Balsam fir	Douglas-fir	Larch	Cedar	Hemlock	Other
Vancouver Island								
Van. Is. (NW) Brooks Block[5]	8	-	19	-	9	62	2	-
Van. Is. (N) Cape Scot Block[6]	6	-	9	-	40	39	6	-
Van. Is. (NE) Sayward Block[7]	-	-	26	12	13	44	5	-
Van. Is. (East and South) Crown and private[8]	-	1	8	45	12	33	1	-
West Van. Is. - Nootka TSA								
(NW) Kyuquot	3	-	19	5	20	51	2	-
(SW) Barkley	3	-	18	4	30	42	3	-
Queen Charlotte Islands								
Queen Charlotte TSA	20	-	-	-	27	49	4	-
Vancouver Region TFL's	1	-	22	8	22	43	4	-
Regional Average	2	-	21	13	21	40	3	-
Cut 1979/80	2	-	19	17	23	36	3	-
Cut 1985/86	3	-	18	16	23	38	2	-

[5] Brooks block of Kingcome TSA shown separately as NW Van. Is.

[6] Cape Scott block of Kingcome TSA shown separately as North Van. Is.

[7] From Campbell River West to the north end of Strathcona Park then generally north along the eastern boundary of TFL #7 to Sayward

[8] Scattered blocks of Crown land and the private forest land along the rail belt between Campbell River and Duncan, Cowichan Bay.